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Producer perceptions and information needs regarding their adoption of bioenergy crops

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ABSTRACT

The availability of reliable information tailored to the needs of producers has a central role in the innovation decision process in agriculture. The authors explored the information needs and preferences for delivery formats and channels of farmers in the state of Illinois, USA, as they consider introducing bioenergy crops in their current production systems. We used surveys and focus groups to target farming populations from northern, central, and southern regions of the state to identify characteristics of potential adopters and evidence of regional differences. In addition, we examined farmers' planning in response to energy uncertainties, and their opinions regarding the optimal crop to meet energy demands. Across the state, 24% of respondents were identified as potential adopters of bioenergy crops; regions within the state showed similar results. The likelihood of adoption increased 16 times if the farmer was categorized as a potential user of alternative fuels and increased two times for each new crop planned for the coming growing season. Four main areas of information needs were identified and categorized as (1) understanding agronomy and markets, (2) concerns and supporting policies, (3) market readiness and business uncertainty, and (4) operational advantages. Though no interaction of region by adopter was found, there are clear statistical differences among regions and potential adopters regarding information needs. Conferences, meetings and field days (venues with a high level of interaction among stakeholders) are preferred delivery formats. Other farmers, neighbors and friends, as well as university and extension services, were the most valued sources of information.

Contents

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1. Introduction

Renewable energy's share of the U.S. market reached 8% during 2009. This was the highest level recorded by the US Energy Information Administration [1]. Power derived from biomass represents the single largest domestic source of renewable energy, and currently supplies almost 4% of the total energy consumption in the US. Interest in biofuels is increasing as federal and state regulations mandate an increasing minimum amount of energy to be generated from renewable sources.

In line with the Renewable Fuel Standard in the Federal Energy Independence and Security Act of 2007, Illinois adopted a renewable energy standard requiring the state's utilities to generate at least 25% of their power from renewable forms of energy by 2025 [1]. In addition, the 2008 Farm Bill established the Biomass Crop Assistance Program (BCAP) to assist agricultural and forest land owners and operators with production and transportation of bioenergy crops, and to support the establishment and production of eligible crops in selected BCAP project areas [2]. Illinois is one of the most suitable states for bioenergy crop production and use, yet there is a critical need for research and extension activities to help the industry achieve this potential. Bioenergy research initiatives (e.g., at the University of Illinois at Urbana Champaign, Energy Biosciences Institute) generate a wide array of information that would be of use to producers. The producers have questions researchers can answer to help stimulate adoption and production of bioenergy crops.

With research activities and financial support in place, the prospect for a thriving bioenergy industry appears promising. Yet, the facilitation of knowledge construction by producers in the early phases of adoption [3] is critical to achieve the potential of the bioenergy industry. About 78% of US citizens believe that using biofuels is a good idea [4], yet little is known of farmers' willingness and ability to substantially increase production of bioenergy crops. Farmers are active learners. They seek and process information to reduce uncertainty about innovations [5,6]. The acquired knowledge and the time spent on this activity determine the attitude about the innovation and thus, the decision to adopt or reject a new idea [7,8].

Relevant and quality information about an innovation that is readily available to the decision-maker reduces the costs associated with information seeking and learning [6,8], while reducing the perception of the innovation as a threat [7]. Features of an innovation, such as costs, benefits, and technical complexity, play a significant role in the decision to adopt the innovation [6,9,10]. Communication source attributes [8,10,11], personal characteristics of the potential adopters, and social context also influence adoption decisions [5,12–14]. In a study concerning farmers' intentions toward biofuel crops in the UK, Mattison and Norris [9] found that a more positive attitude and fewer perceived difficulties with production indicated greater adoption potential.

Using focus group methodology, Sherrington et al. [10] discussed the farm-level constraints on the domestic supply of perennial energy crops in the UK. Participant farmers agreed the main limiting factor for adoption was current uncertainty about the financial viability of energy crops. Using a choice experiment approach with farmers in Sweden, Paulrud and Laitila [15] found that farmers' willingness to grow energy crops was mainly affected by the lack of knowledge needed to successfully grow and harvest these crops. So, even when energy crops would increase net income, the expected cultivated area remained small. In the US, farmer willingness to grow switchgrass for energy production was investigated by Jensen et al. [12], who conducted a survey of Tennessee farmers and found a minority of respondents (~21%) with previous knowledge about growing switchgrass for energy. There was a significant association between previous knowledge of switchgrass and farmers' interest in growing switchgrass. The authors used a Tobit model to evaluate the effect of several farm and producer features on the share of farmland they were willing to convert, and found that age of the farmer, size of the farm, net farm income, level of education and the presence of a diversified crop portfolio all reduced the share of land allocated for switchgrass. Villamil et al. [13] surveyed producers about their information needs and preferred channels of communication regarding potential adoption of *Miscanthus* as an energy crop in Illinois. Regions within Illinois vary in climate, topography and soil characteristics which affect cropping systems. Combined with socio-economic factors, these variations led to differences in demographics and diversity of farming activities. Thus, information needs of producers varied by region. Most of the farmers were unaware of *Miscanthus* before completing the survey, yet about 30% of the respondents indicated an interest in growing it, given the existence of markets and infrastructure for miscanthus production. Compared with potential adopters, potential non-adopters stressed the risks and demanded more information to reduce the uncertainties and risk of *Miscanthus* production. The current project broadens that perspective to include other energy crops under consideration in Illinois.

Our objective was to explore producers' opinions, information needs, and preferred delivery formats and channels regarding bioenergy crop production in Illinois, and to identify and profile potential adopters. We expect the results of our study to improve the effectiveness of future communication efforts among stakeholders.

2. Materials and methods

A survey was used to explore producers' opinions, information needs, and preferred information delivery formats and channels for bioenergy crop production in Illinois, and to identify and profile producers who were likely to adopt biofuel crops. Survey results were further analyzed using focus group methodology. Data were collected between February 2009 and March 2010. The survey instrument is available online as supplementary material (see Appendix).

2.1. Survey of Illinois farmers

The target population for this study was all farmers in Illinois. Differences in climate, topography, and soils result in different cropping systems and farm typology from north of to south and east to west regions of the state. The study was organized around three distinct agricultural regions customarily titled, North, Central, and South. The regions were aligned with those used by the Illinois Field Office of the National Agricultural Statistical Service (NASS). The self-administered mailed survey was designed following the recommendations of Dillman et al. [16] and the survey instrument was examined for content and face validity by faculty members of the Departments of Human and Community Development and Crop Sciences of the University of Illinois at Urbana Champaign, and University of Illinois Extension educators.

The survey instrument has four sections. In the first section, one set of Likert-type scale items elicited plans to change farm operations in consideration of "the rising cost of energy." Items in this section were used to identify potential adopters of energy crops. Our working definition of "potential adopters" is those farmers who are willing to plant a biofuel crop and who will allocate land to that end. Potential adopters are producers who answered "will do it next year" or "will do it in the next five years" to item 1c "plant a fuel crop" and who are also willing to allocate some acreage to bioenergy crops during "the next season" or "within the next 5 years or so" (question 8). A dummy variable that identified

potential adopters was created for statistical purposes. Each respondent who fulfilled both requirements (plant and allocate land) was categorized as a "potential adopter" and assigned a value of 1. When conditions were not present, a value of 0 was assigned, implying non-adoption. The second set of questions listed crops and products that "have potential for success to meet our future needs for energy." Respondents rated each item from "very likely" to "not likely."

The second section of the survey also used a Likert-type scale with 32 items (questions 4 and 5 of the survey instrument) to explore the information needs of farmers if they were to consider adopting energy crops. Missing item scores were removed listwise. Only cases with valid values for all variables are included in the analyses.

The third section of the survey was designed to collect opinions regarding the usefulness of the communication media listed (question 6) and the value attributed to each source of information listed (question 7). The last section gathered demographic information such as age, gender, years of farming full and part-time, area farmed, area owned, and agricultural activities currently on the farm. The survey included a final open-ended question which enabled respondents to provide additional comments on the subject. Open ended responses were not included in the analysis.

The Illinois Field Office of the National Agricultural Statistical Service (NASS) randomly selected and sent the survey packet to 1200 farmers in each region, for a total of 3600 mailed survey packets. To increase response rates, all envelopes and letters used official letterhead and first-class stamps. A personalized cover letter accompanied the survey and a postage paid reply envelope was included. A follow-up survey was sent 2 weeks after the first mailing to all 3600 addresses. Respondents were then categorized as 'early' and 'late' respondents and contrasted on key demographic variables to handle non-response issues following Miller and Smith [17]. In this way, late respondents were used as a proxy for the profile of non-respondents and the lack of statistical differences thus justifies generalizing for the respondents to the sample.

Of the 3600 surveys sent, a total of 1113 were returned, for a response rate of 31%. Out of the total sample pool, 111 surveys were returned without completing more than 50% of the questionnaire, giving a refusal rate of 3%, with 1002 responding for a final response rate of 28%. The response rate was in line with expectations of 20% given the length of the questionnaire, the "future intentions" nature of the survey questions, and no monetary incentive.

2.2. Data analysis

Four dependent variables were derived from the 32 questions that measured farmers' information needs when considering the adoption of bioenergy crops. Principal axis factoring (PAF) with varimax rotation was used to reduce the available items to a smaller set of composite variables for use as dependent variables in multivariate ANOVA. Data were deemed appropriate for factoring as indicated by the high value of the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO, 0.94) and by the Bartlet's test statistic which indicated a significant ($p < 0.0001$) departure from orthogonality of the correlation matrix (i.e., the variables are correlated among themselves) [18]. Variables with a minimum loading of 0.45 were selected for inclusion in defined components. A reliability analysis was carried out on the composite variables and since all the measures produced a minimum coefficient α of 0.70 (Table 1), they were regarded to be appropriate for further analysis.

Four factors emerged from the analysis and were named F1: understanding agronomy and markets, F2: concerns and supporting policies, F3: market readiness and business uncertainty, and F4: operational advantages. Table 1 shows the resulting factors with their corresponding α's, variables, and loadings for each variable. The variables have standardized values; a higher loading of a variable on a factor indicates a greater contribution of the variable toward the information need represented by that particular factor. The information factors were used as dependent variables in a multivariate ANOVA to detect regional differences and the information needs of potential adopters.

Table 1
Dependent variables (factors) derived from principal factor analysis (PAF) with their corresponding α's (in brackets), variables, and loadings for each variable.

	Loading
F1: Understanding agronomy and markets ($\alpha = 90$)	
Pest control/management	0.78
Production practices	0.77
Information about harvesting, transportation and storage	0.75
Soil fertility requirements	0.75
Controlling the crop (so that it doesn't become a weed)	0.66
Contracting to grow the crop	0.64
How a new crop would fit into my current farming operation	0.61
Markets and marketing	0.61
Cost/benefit analysis to compare energy crop options	0.60
Crop removal if the crop is taken out of the rotation	0.58
F2: Concerns and supporting policies ($\alpha = 84$)	
Creating jobs in my community	0.61
Reducing carbon dioxide emissions	0.59
Reducing nitrogen runoff	0.58
Government policy and incentive programs	0.56
Concern about using resources to produce food vs. fuel	0.55
Government subsidy	0.54
Effects on water quality	0.53
Using biofuels on your farm	0.52
The availability of enough water to process the crop	0.49
F3: Market readiness and business uncertainty ($\alpha = 78$)	
Infrastructure to use the energy crop (transportation, power plants, etc.)	0.58
Market potential for the crop	0.57
Maximizing energy output from energy input	0.50
Potential for other uses (and markets) in addition to energy	0.50
Improved national energy security	0.46
F4: Operational advantages ($\alpha = 86$)	
Reducing wear and tear on equipment	0.78
The opportunity to reduce labor	0.75
The opportunity to reduce inputs	0.66

Descriptive statistics identified general trends in the data set and provided information about the variables used in this study. Multivariate ANOVA (for continuous variables) and Chi-square (χ^2) tests (for categorical variables) were used to uncover differences in farmers' information needs, opinions, and demographics among regions and between potential adopters and non-adopters.

To investigate factors affecting adoption, the dichotomous variable created to identify adopters was regressed on several variables using a logistic regression with a stepwise regression procedure to select the best subset of predictors [19]. The literature suggests characteristics of the producer such as age and farming experience; and characteristics of the farm operation such as location, ownership and diversification [5,12–14]. Thus, covariates included: (1) age of the farmer, "age," (2) the region of Illinois where the operation is located, (3) the number of years the producer had farmed full time, (4) the number of hectares farmed, (5) the number of hectares owned by the producer, (6) the area of land enrolled in the Conservation Reserve Program (CRP), (7) the number of activities currently in the farm portfolio, (8) the number of new crops planned for the coming production year, "new crops," (9) whether or not the producer had livestock, and (10) whether or not the producer would use alternative fuels, "user." The latter variable was constructed from question 1, in which respondents stated "will do it next year" or "will do it in the next 5 years" to item 1f "Use biofuels on my own farm and/or in my home" and/or item 1 g "Use alternative fuels available in the market." A "Potential user" variable was

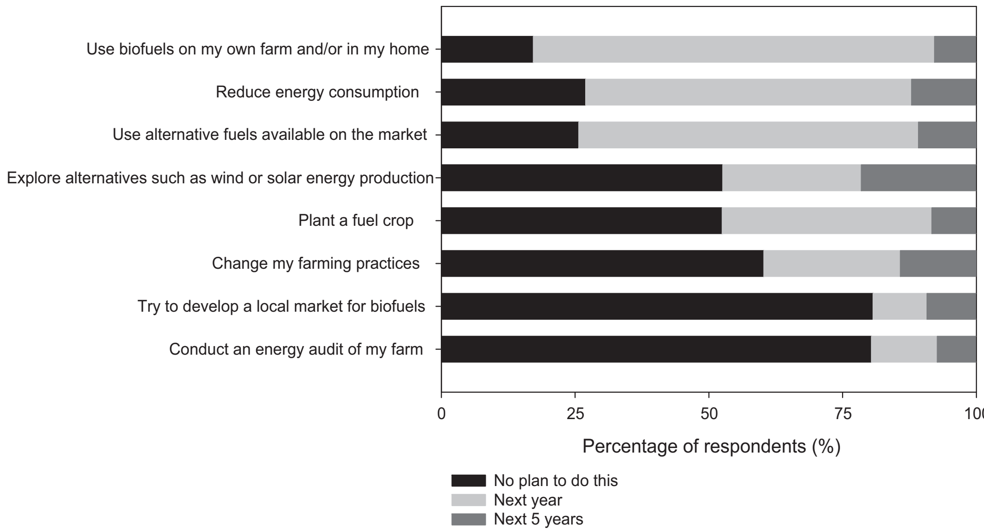

Fig. 1. Producers' plans in the near future to confront the energy crisis.

Table 2
Demographic characteristics of Illinois farmers and number of potential adopters and users of biofuels identified by region.

Variable	Total	Southern	Central	Northern	Sig[a]
Respondents (n)	1002	284	361	357	
Age					*0.915*
Mean	58	58	58	58	
Standard error of mean (SE)	0.4	0.8	0.7	0.6	
Gender					0.363
Male	953	269	342	342	
Female	31	7	15	9	
Years farming					
Full time					*0.004*
Mean	27	24	28	28.3	
SE	0.6	1.1	0.9	0.9	
Part time					*0.035*
Mean	6.7	8.4	5.8	6.2	
SE	0.4	0.9	0.7	0.6	
Total years farming					*0.461*
Mean	35	34.2	34.9	35.7	
SE	0.5	0.9	0.8	0.8	
Land area farmed (ha)					*0.007*
Mean	351.7	316	399.3	331	
SE	11.7	21.9	21.1	17.4	
Percentage of land in CRP					*0.493*
Mean	3.9	4.4	4.1	3.3	
SE	0.4	0.6	0.7	0.7	
Land area owned (ha)					*0.078*
Mean	153.3	150.3	170.9	137.7	
SE	6.3	9.8	12.6	9.2	
Number of farm activities					*0.000*
Mean	2.8	3.1	2.6	2.7	
SE	0	0.1	0.1	0.1	
Farm activities (number of farms)					
Corn	935	257	348	330	
Soybean	914	259	340	315	
Wheat	294	172	72	50	
Livestock	279	102	74	103	
Forage crops	198	67	55	76	
Fruits and vegetables	40	6	12	22	
Energy crops[b]	10	2	3	5	
Potential adopters n	240	63	85	92	0.558
% of respondents	24.0	22.2	23.5	25.7	
Potential users n	755	197	277	281	0.018
% of respondents	75.3	69.4	76.7	78.7	

[a] Significance of the multivariate F test (in italics) for continuous variables and of the χ^2 test (in normal font) for categorical variables.
[b] The numbers involve *Miscanthus* (1 grower in northern IL), fuel wood (1 grower in northern and 1 in central IL), and corn for ethanol (7).

created by assigning a value of 1 when the previous condition was met and a value of 0 when no plan was indicated.

Maximum likelihood estimates of the regression parameters and their standard errors were calculated and Chi-square (χ^2) was used to test the significance of each regression parameter. From the fitted model, a predicted event (= *adopter*) odds ($p/1-p$) can be computed for each farmer. If the predicted event odds exceed the cutoff value of 0.5, the farmer is predicted to be an adopter; otherwise, the farmer is a non-adopter. Odds ratios express the likelihood of adoption of bioenergy crops more under one condition than another (i.e., planning to use biofuels vs. not planning to use) holding all other variables constant. If the confidence interval (CI) of the odds ratio for a given parameter in the equation includes 1, there is no difference in the likelihood of adoption of bioenergy crops for the two conditions. If both CI endpoints are greater than 1, adoption is more likely under the first condition (e.g., planning to use biofuels) and if both CI endpoints are less than 1, then adoption is more likely under the second condition (e.g. not planning to use biofuels). Also, when calculating an odds ratio for a variable such as number of hectares farmed, the likelihood of adoption for a farmer with $x+1$ ha farmed (e.g., 150) is compared with a farmer with x hectares farmed (e.g., 149). The selected model with the parameters shown in Table 3 achieved 75% of correct classification and the Hosmer–Lemeshow lack-of-fit test indicated a reasonable model fit. Statistical analyses were carried out using PASW Statistics 18 [20].

2.3. Focus groups of Illinois farmers

Focus groups followed the mailed survey to delve into the rationale and motivations behind survey responses. Seven focus groups were conducted in five counties throughout Illinois: (1) Bureau and Lasalle (North), (2) Christian (Central), and (3) Randolph and Franklin (South). Participant numbers averaged six per session. Each group addressed seven questions closely related to the survey questions. The conversations were transcribed and analyzed for trends and patterns in the responses.

3. Results and discussion

3.1. Demographics of Illinois farmers

Demographic characteristics of the studied population are presented in Table 2 for the total sample and by region. Demographic data are in agreement with the trends shown by the 2007 Census of Agriculture [21]. The average age of respondents is 58 years; most are male operators farming an average of 352 ha of which they own about 44%. Conservation reserve program (CRP) land averages 4% throughout the state. Farmers in Illinois are experienced, averaging almost 35 years of farming and more than 27 years of full-time farming. Illinois ranks second nationally in the production of corn and soybeans. These are the top two agricultural commodities in the state, followed by wheat, livestock, and forage crops. Regional differences of topography and weather are reflected in many of these demographic parameters, including years of full-time farming, land farmed and owned as well as the number of activities (i.e., different crops and livestock). Southern Illinois farmers have more years of part-time farming (and fewer years full-time) and farm fewer acres; yet, they owned significantly more land (∼47%) than farmers in the central region. Southern Illinois farmers produce more wheat, forages and livestock than farmers in the other regions. The latter activities also are important in northern Illinois. About 1% of respondents acknowledged the production of energy crops in their farm operation; 70% of those were referring to corn used for ethanol.

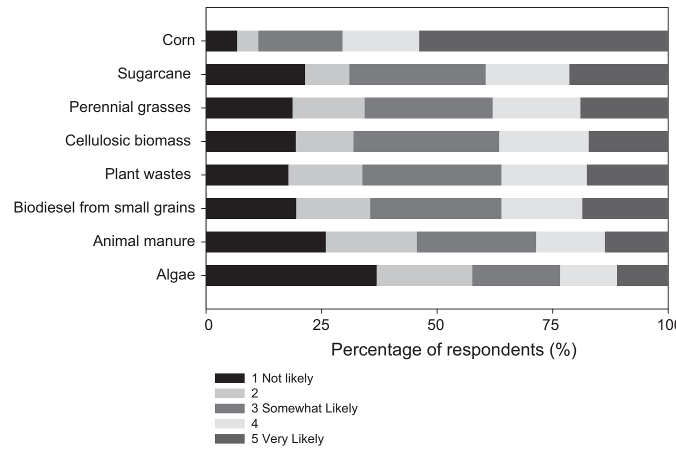

Fig. 2. Producers' opinion regarding crops that will address the demands for bioenergy.

Following the selection criteria described in Section 2, 24% of respondents state-wide were identified as "potential adopters" of bioenergy crops, with similar proportions in each region (Table 2). More than 75% of the respondents qualified as potential alternative fuel users, which may enlarge the market for potential adopters. The number of users in southern Illinois was significantly lower than for other regions of the state.

3.2. Farmers' plans and opinions

Fig. 1 shows the percent of responses for different near future plans in the farm operation when considering the rising cost of energy. Responses fell into one of three categories (1) no plan to do this; (2) will do it next year; and (3) will do it in the next 5 years. The top three producers' plan choices were using biofuels on the farm and/or the home (75% next year, 8% in the next 5 years); reducing energy consumption (61% next year, 12% in the next 5 years); and using alternative fuels available on the market (64% next year, 11% in the next 5 years). Between 40% and 48% of respondents will consider solar and wind energy production, planting a biofuel crop, and changing farming practices in the near future. Less than 20% indicated an interest in developing local markets for biofuels or conducting energy audits of their operations. Fig. 2 shows farmers' opinions of the potential for success of different crops and products in helping to meet future energy needs. More than 70% of respondents believe that corn will be the "likely" or "most likely" future source of bioenergy. The response frequencies were similar for sugarcane (39%), perennial grasses (38%), cellulosic biomass (37%), biodiesel from small grains (37%), and plant wastes (36%), while animal manure and algae were the options regarded as least likely. Fig. 3 shows the 519 responses to questions about new crops under consideration in farm operations the following season. The top choice is corn (67%), but producers also are considering planting *Miscanthus* (5% of producers) and switchgrass (8% of producers).

3.3. Profiling potential adopters

Table 3 shows the results from logistic regression that indicates the following variables "new crops," "user," and "age" are the most important variables in determining whether a producer will adopt bioenergy crops. The odds ratio of using alternative fuels (Table 3) indicates that being classified as a "potential user" increases the odds of adoption 16 times with a confidence interval (CI) for this parameter ranging from 6.9 to 37 times. The odds of adopting bioenergy crops were 2 times (CI, 1.6–2.5) higher for each new crop planned for the coming season. In addition, the odds of adoption

Table 3
Results from the stepwise logistic regression indicating the maximum likelihood estimates for the variables included in the model, and test of significance in predicting whether or not farmers are willing to adopt energy crops in Illinois.

Parameter	DF	Estimate	SE	Wald χ^2	Sig	Odds ratios	95%CI	
							Lower	Upper
New crop	1	0.69	0.11	41.38	0.00	2.00	1.62	2.47
Potential user	1	2.77	0.43	41.98	0.00	16.01	6.92	37.06
Age	1	−0.02	0.01	7.20	0.01	0.98	0.97	0.99
Constant	1	−2.91	0.59	23.95	0.00	0.05		

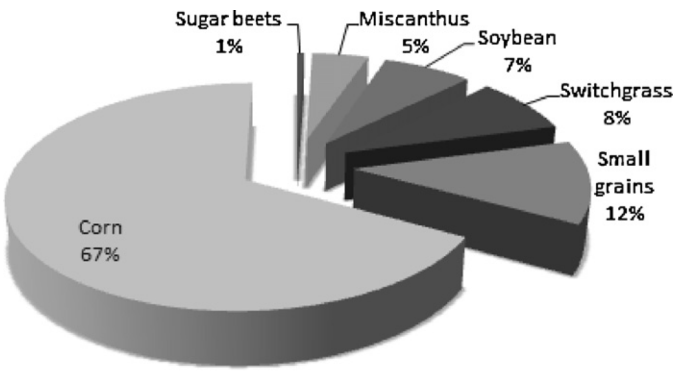

Fig. 3. New crops under consideration for the following growing season ($n = 519$).

decrease with an increase in age of the producer (~1 time per year of age increase).

Fig. 4 reveals the distribution of land allocated to bioenergy crops anticipated by potential adopters. For the next growing season, 40% of the potential adopters would be willing to allocate between 0.4 and 20 ha, while about 19% of adopters would allocate more than100 ha for bioenergy crop production. Considering "the next 5 years or so," 23% of the potential adopters plan to allot between 0.4 and 20 ha, whereas 31% would plant more than 100 ha to bioenergy crops. When potential land allocations are summed, they represent up to 14,827 ha of bioenergy crops planted in the next growing season, and more than 25,808 ha in the next five production years in Illinois.

3.4. Information needs: regional differences

Fig. 5a shows the differences among regions regarding the information needed to inform the decision to produce a bioenergy crop ($p < 0.04$). Factors are standardized variables (mean 0, std dev 1) thus, values range from −3 to 3. Because all meaningful factor loadings were positive (Table 1), higher factor means represent a greater contribution of a particular factor toward the information needs of a region or adopter category. Among regions, the difference in information needs centered around agronomy and markets and operational advantages (Fig. 5a). While farmers from northern and southern Illinois are equally interested in a variety of decision making information, the weight they place on information regarding understanding agronomy and markets (F1) and operational advantages (F4) is significantly different. Farmers in southern Illinois centered their interests in the operational advantages (F4) of including bioenergy crops, while requesting

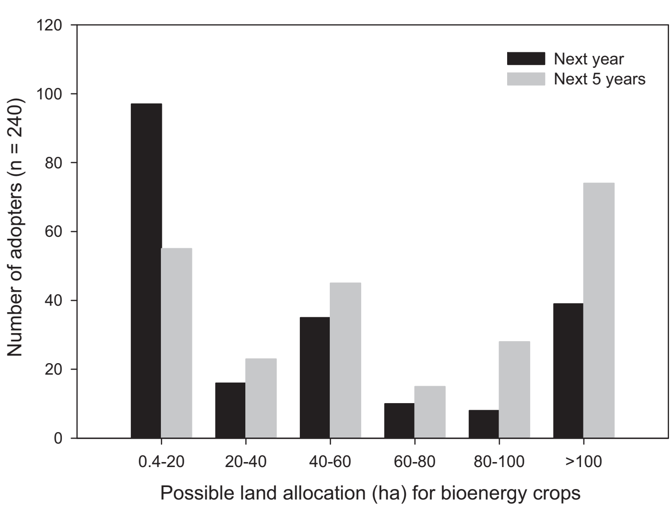

Fig. 4. Anticipated land allocation for bioenergy crops by potential adopters during "the next growing season" and "the next five production years.".

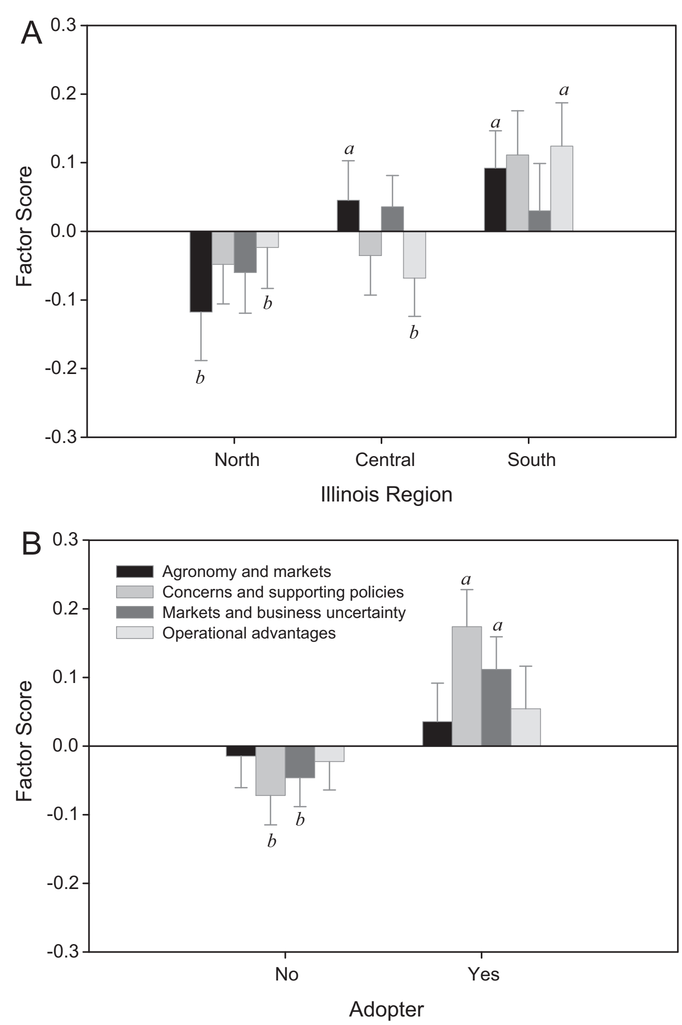

Fig. 5. Differences in information needs (A) among regions and (B) between potential adopters (yes) and non-adopters (no). F1: Understanding agronomy and markets; F2: Concerns and supporting policies; F3: Markets and business uncertainty; F4: Operational advantages. For a given factor, different lowercase letters indicate statistical differences.

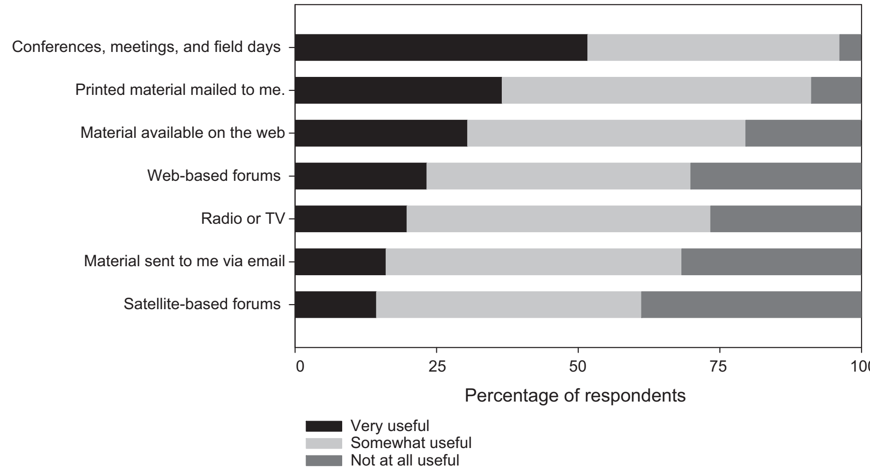

Fig. 6. Perceptions of potential adopters regarding media usefulness for the acquisition of agricultural related information.

agronomy and markets (F1) knowledge to be available. Central Illinois farmers consider knowledge and understanding of agronomy and markets (F1) crucial when considering their adoption of bioenergy crops. There were no differences among the regions in the weight given to the need for information regarding concerns and supporting policies, or market readiness and business uncertainty (Fig. 5a). The importance of these factors is not less but equal among regions and its significance becomes clear when considering the information needs of potential adopters and non-adopters (Fig. 5b).

3.5. Information needs: differences between adopters and non-adopters

There were no statistical differences in the information needs of adopters and non-adopters among regions of the state, evidenced by the lack of significance of the interaction term ($p < 0.89$). Yet, there is a significant difference between state-wide adopters and non-adopters ($p < 0.00$), plotted in Fig. 5b. Throughout the state, non-adopters focus on the risks bioenergy crops present expressed by concerns and policy support (F2) and market readiness and business uncertainty (F3) when compared to potential adopters (Table 1).

In a study conducted in Greece regarding public acceptance of biofuels [22], respondents willing to use them believed biofuels could be an effective strategy against energy insufficiency and climate change. These potential users were also supportive of more employment in the agriculture sector that might occur with greater production of biofuel crops. That same information is important to Illinois adopters as summarized by factors F2 and F3 (Table 1). The social concerns of factors F2 and F3 appear to motivate some Illinois farmers to be biofuel adopters. The extra-farm value helps explain our finding that the likelihood of adoption of biofuel crops increases if a producer is also identified as a potential user of biofuels (Table 3). A survey of Illinois consumers or end users of biofuels prepared by our research group is underway to validate the hypothesis that social concerns are related to consumers' adoption behavior.

3.6. Preferred information channels and trusted sources

To be effective, the information potential adopters need should be channeled through appropriate and trusted sources, and preferred media. Producers were asked to rate several media with regard to usefulness in informing their cropping decisions. Chi-squared tests were conducted to evaluate regional differences

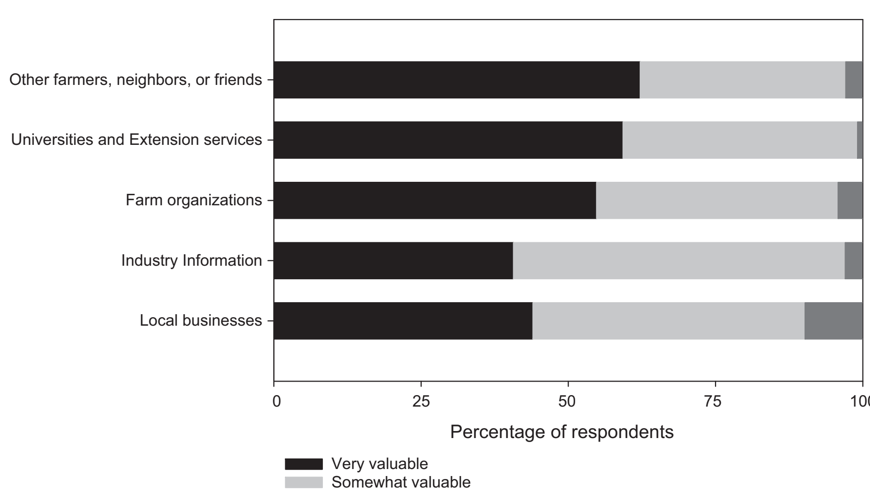

Fig. 7. Valuation of sources of agricultural related information by potential adopters.

in the proportion of media sources categorized as "very useful," "somewhat useful," and "not at all useful" by potential adopters. No differences among regions were identified for these variables. Fig. 6 shows the percentage of potential adopters that classified different media as "very useful," "somewhat useful," and "not at all useful." Conferences, meetings and field days with a high level of stakeholder interaction were the preferred delivery format, with 52% of the respondents selecting this category as "very useful." Printed material mailed to the farmer was the second choice, with 37% selecting as "very useful." Less than 25% ranked web- or satellite-based forums, emails, and even radio or TV, as useful.

In addition, producers ranked several information sources regarding their value for cropping decisions. Chi-squared tests were conducted to evaluate regional differences among potential adopters in the proportion of information sources classified as "very valuable," "somewhat valuable," and "not at all valuable." No differences among regions were identified for these variables. Fig. 7 summarizes the findings showing the percentage of potential respondents that classified sources as "very valuable," "somewhat valuable," and "not at all valuable." The top three choices considered "very valuable" by respondents were other farmers and neighbors (62%), universities and extension services (59%), and farm and agricultural organizations (55%). Information channeled through industry and local business was deemed very valuable by 41% and 44% of respondents, respectively.

3.7. Focus groups findings

Participants were interested and wanted to learn more about energy crops, but they also expressed concerns and broad consensus about potential barriers to widespread adoption of energy crops. Financial support and security was the first concern, since the main competing agricultural crops (corn and soybeans) currently work well together in all aspects considered (agronomy, markets, and policies). Corn and soybeans have many uses and can be sold to several markets, including energy production. For these farmers to consider a new crop, it would have to match or surpass the economic and logistical benefits of corn and soybeans. Most farmers agreed that there must be reliable markets for a crop before they will grow it, and that a single market may not provide enough stability to entice farmers to grow the crop. Participant farmers valued crop residue as a soil fertility builder and not as a fuel feedstock and expressed their desire to sustain soil resources.

None of the participants was energy self-sufficient or grew energy crops other than corn. Following the trend of post-WWII specialization, farmers do not consider producing energy for their own on-farm use, since on-farm energy production detracts from the primary business. Energy consumption is only one issue farmers consider in business planning. Improvements in energy efficiency are the result of improved farming practices and business efficiencies, e.g., old equipment is replaced with more efficient machinery, no-till farming reduces trips and fuel use, and new crop varieties add up to more production with less input.

Farmers are not accustomed to direct questions about their information needs. They ask long standing, trusted sources (University Extension Educators and researchers, seed sales staff, agronomists, etc.) to answer their questions, and they watch and learn from each other. Finally, they agreed that local, on farm, large-scale demonstrations are the best direct communication strategy.

4. Conclusions

These results have important implications for researchers, extension educators, and policy makers interested in a thriving biofuel industry for Illinois and the United States. In Illinois, 24% of farmers were identified as potential adopters of bioenergy crops. Though all farmers (adopters and non-adopters) recognized the need for technical assistance, potential adopters required more information about environmental and social concerns of biofuel production, governmental policies and subsidies, and uncertainties regarding markets and infrastructure. Adopter information requirements are consistent with the finding that adoption is 16 times more likely if the producer also is identified as a potential user of biofuels. Thus, more potential adopters may actually adopt biofuel crops if they are informed about biofuels (environmental benefits, job creation in agriculture), and have access to information that addresses general concerns (food vs. fuel, water availability) and farm financial security. Since more than 70% of Illinois producers believe that corn will be the primary and future source of bioenergy, information about competitive alternative options should be made available to producers to generate a more diversified biofuel economy. To be effective, high quality information must be communicated with a high level of stakeholder involvement. That can be achieved with the producer preferred methods of farmer-researchers workshops, field days, on-farm demonstrations, participatory on-farm research, and farmer led groups.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.rser.2012.03.033.

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